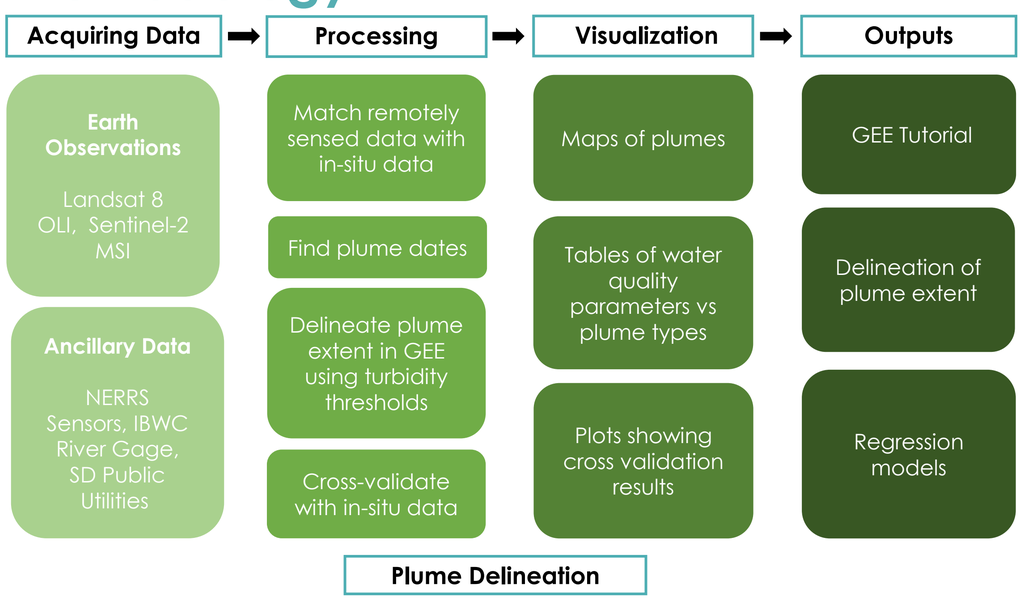
Monitoring Runoff Plumes Originating from the Tijuana River Estuary To Inform Water Quality Management

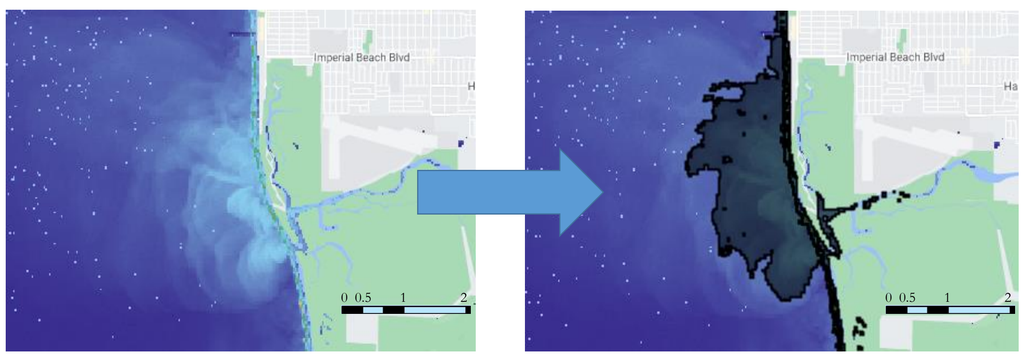
Abstract

Storm and wastewater runoff are large sources of pollutant discharge along the southern California coast and are major concerns pertaining to the health of local communities and ecosystems. However, studying the deteriorated water quality caused by these events along the coasts can be difficult given the dynamic nature of winds and currents. This project utilized satellite imagery and the Optical Reef and Coastal Area Assessment (ORCAA) Google Earth Engine tool to visualize and analyze the water quality of the San Diego coast after major storm and wastewater events as an alternative for in-situ sampling. Using Landsat 8 Operational Land Imager (OLI) and Sentinel-2 Multispectral Instrument (MSI), the team analyzed the extent of pollution plumes released from the Tijuana River Estuary from 2013 to 2022 and estimated water quality parameters, such as colored dissolved organic matter (CDOM). Remotely-sensed turbidity, chlorophyl-a, and CDOM were also cross validated with in-situ data from NOAA and the San Diego Public Utilities in the San Diego coastal area to evaluate the accuracy of water quality data derived from satellite imagery.

Methodology



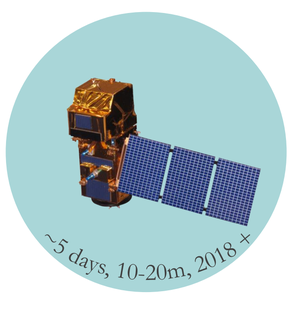
Plume Delineation



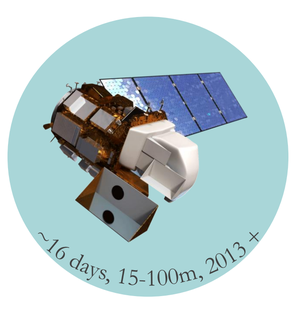
Objectives

- **Improve** the monitoring of pollution plumes along the southern California coast by incorporating remote sensing capabilities
- **Create** a tool that can delineate pollution plumes from satellite imagery in GEE
- **Assess** water quality parameters, such as turbidity and colored dissolved organic matter (CDOM)
- **Evaluate** the effectiveness of using satellite imagery to estimate water quality parameters

Earth Observations



Sentinel-2 Multispectral Instrument
Level 2A Surface Reflectance



Landsat 8 Operational Land Imager
Level 2 Surface Reflectance Tier 1

Team Members

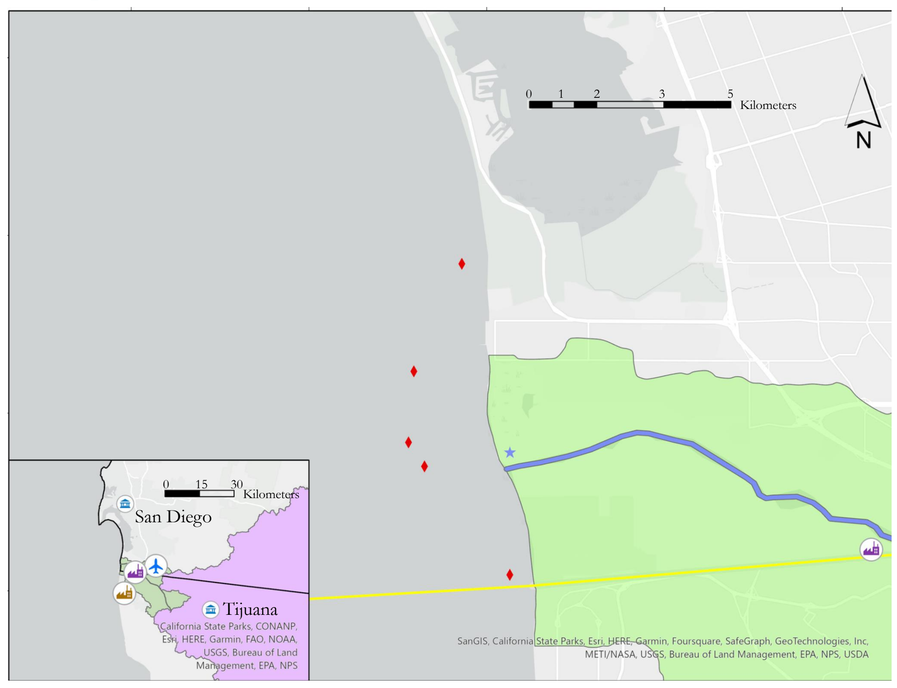
Ethan Gates
Project Lead

Stefanie Mendoza

Max VanArnam

Jonathan Szeto

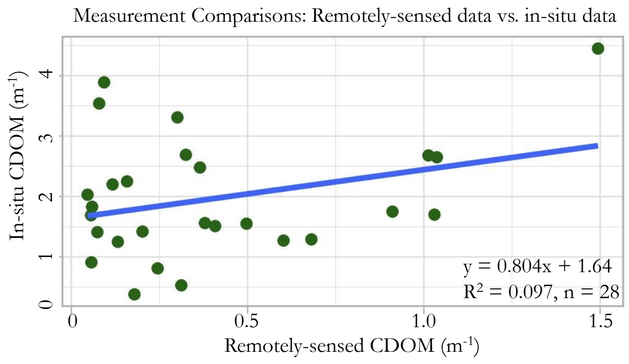
Study Area

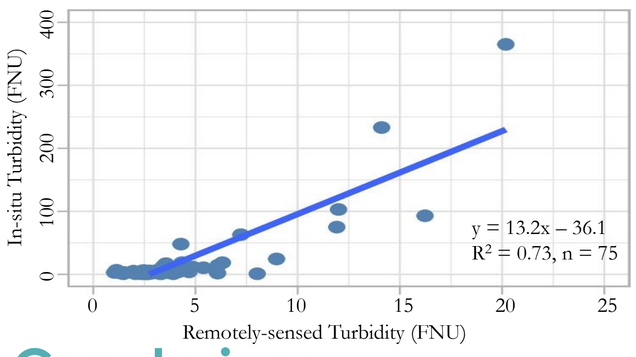


Results

Plume Type	Turbidity Thresholds	Area (mi^2)	CDOM (m^{-1})	Turbidity (FNU/NTU)	Chlorophyll-a (µg/L)
Storm	3.48	4.18	1.04	5.59	5.26
Waste	1.44	3.17	0.12	5.06	1.85
Mixed	1.86	4.18	0.34	5.29	2.89

Measurement Comparisons: Remotely-sensed data vs. in-situ data





Conditions	Equation	R^2	Sample Size (n)
CDOM (all)	0.804x + 1.64	0.097	28
Chl-a (all)	0.772x + 4.79	0.47	10
Turbidity (all)	13.2x - 36.1	0.73	75
Turbidity (Stormwater)	16.0x - 64.4	0.73	19
Turbidity (Wastewater)	0.0930x + 2.51	0.030	35
Turbidity (Mixed)	1.56x + 0.517	0.20	23

Conclusions

- Turbidity thresholds to map mixed, storm, and wastewater plumes extent were established
- Stormwater plumes tend to be larger and have more severe water quality indexes
- Remotely-sensed data accurately estimates turbidity and chlorophyll-a.
- Remotely sensed data more accurately estimates turbidity for stormwater than wastewater.
- Further analysis is need to evaluate measuring CDOM with remote sensing.

Project Partners

- San Diego Regional Water Quality Control Board
- Water Keeper Alliance
- Tijuana River National Estuarine Research Reserve
- City of San Diego and City of Imperial Beach

Acknowledgements

The San Diego Water Resources Team would like to thank Dr. Juan Torres-Pérez, Dr. Daniel Sousa, Dr. Christine Lee, Benjamin Holt, Dr. Kenton Ross, Mariam Ayad, Britnay Beaudry, and Lisa Tanh on their guidance, constructive feedback, time, and support throughout this project. We would also like to acknowledge former DEVELOPers Hayley Pippin, Arbyn Olarte, Roxana Pilot, and Vanessa Valenti for developing the ORCAA tool.

This material contains modified Copernicus Sentinel data (2017-2022), processed by ESA.

San Diego Coast Water Resources

DEVELOP

This material is based upon work supported by NASA through contract NNL16AA05C. Any mention of a commercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organizations.